CLAIMS

I claim:

1. A method for imaging prestack seismic data, comprising:
calculating an individual reflectivity for each frequency in the seismic data;
calculating a mean reflectivity over the individual reflectivities;
calculating a variance for the individual reflectivities;
calculating a variance for the upgoing wavefield, using the mean reflectivity;
calculating a spatially varying pre-whitening factor, using the variance for the reflectivities and the variance for the upgoing wavefield; and
calculating a reflectivity using the spatially varying pre-whitening factor.

2. The method of claim 1, wherein the step of calculating a variance for the upgoing wavefield comprises applying the following equation:

$$\sigma_U^2(\mathbf{x}) = \frac{1}{n-1}\sum_{j=1}^{n}\left[U(\mathbf{x},\omega_j) - \langle R(\mathbf{x})\rangle \cdot D(\mathbf{x},\omega_j)\right]^2,$$

where $\sigma_U^2(\mathbf{x})$ is the variance for the upgoing wavefield, x is the spatial location, n is the number of frequencies ω_j, $U(x,\omega_j)$ is the upgoing wavefield, $<R(x)>$ is the mean reflectivity, and $D(x,\omega_j)$ is the downgoing wavefield.

3. The method of claim 1, wherein the step of calculating a spatially varying pre-whitening factor comprises applying the following equation:

$$\varepsilon(\mathbf{x}) = \frac{\sigma_U^2(\mathbf{x})}{\sigma_R^2(\mathbf{x})},$$

where $\varepsilon(x)$ is the spatially varying pre-whitening factor, σ_U^2 is the variance for the upgoing wavefield, and $\sigma_R^2(\mathbf{x})$ is the variance for the reflectivities.

4. The method of claim 1, wherein the step of calculating a reflectivity using the spatially varying pre-whitening factor comprises applying the following equation:

$$R(\mathbf{x}) = \frac{1}{n}\sum_{j=1}^{n} \frac{U(\mathbf{x},\omega_j)\, D^{*}(\mathbf{x},\omega_j)}{|\,D(\mathbf{x},\omega_j)\,|^{2} + \dfrac{\sigma_U^2(\mathbf{x})}{\sigma_R^2(\mathbf{x})}},$$

where $R(x)$ is the reflectivity, x is the spatial location, n is the number of frequencies ω_j, $U(x,\omega_j)$ is the upgoing wavefield, $D(x,\omega_j)$ is the downgoing wavefield, σ_U^2 is the variance for the upgoing wavefield, and $\sigma_R^2(x)$ is the variance for the reflectivities.

5. A method for imaging prestack seismic data, wherein a least squares approach comprises applying the following equation:

$$R(\mathbf{x}) = \frac{\dfrac{1}{n}\displaystyle\sum_{j=1}^{n} D^{*}(\mathbf{x},\omega_j)\, U(\mathbf{x},\omega_j)}{\dfrac{1}{n}\displaystyle\sum_{j=1}^{n} D^{*}(\mathbf{x},\omega_j)\, D(\mathbf{x},\omega_j) + \varepsilon},$$

where $R(x)$ is the reflectivity, x is the spatial location, n is the number of frequencies ω_j, $U(x,\omega_j)$ is the upgoing wavefield, $D(x,\omega_j)$ is the downgoing wavefield, and ε is a pre-whitening factor.